

Title Apple mealiness detection using hyperspectral scattering technique
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Abstract

Mealiness is a symptom of fruit physiological disorder, which is characterized by abnormal softness and lack of free juice in the fruit. This research investigated the potential of hyperspectral scattering technique for detecting mealy apples. Spectral scattering profiles between 600 and 1000 nm were acquired, using a hyperspectral imaging system, for 'Red Delicious' apples that either had been kept in refrigerated air at 4 °C or undergone mealiness treatment at 20 °C and 95% relative humidity for various time periods of 0–5 weeks. The spectral scattering profiles at individual wavelengths were quantified by relative mean reflectance for 10 mm scattering distance for the test apples. The mealiness of the apples was determined by the hardness and juiciness measurements from destructive confined compression tests. Prediction models for hardness and juiciness were developed using partial least squares regression (PLS); they had low correlation with the destructive measurement ($r \leq 0.76$ for hardness and $r \leq 0.54$ for juiciness). Moreover, PLS discriminant models were built for two-class ('mealy' and 'nonmealy'), three-class ('mealy', 'semi-mealy' and 'fresh') and four-class ('mealy', 'soft', 'dry', and 'fresh') classification. The overall classification accuracies for the two classes of 'nonmealy' and 'mealy' apples were between 74.6% and 86.7%, while the overall accuracies in the three-class classification ranged between 60.2% and 71.2%. Much better results ($\geq 93\%$ accuracy) were achieved for the two-class classification of 'mealy' apples that had undergone longer time of mealiness treatment (i.e., 4–5 weeks of storage at 20 °C and 95% relative humidity). Hyperspectral scattering technique is potentially useful for nondestructive detection of apple mealiness; however, improvements in classification accuracy are needed.